METHOD FOR PRODUCING A BENDING-RESISTANT, ELONGATED BODY AND AN ARRANGEMENT FOR A BENDING-RESISTANT, ELONGATED BODY

The present invention relates to a method for producing a bending-resistant, elongated body, preferably a shaft or beam, as indicated in the preamble to claim 1.

The invention also relates to an arrangement for a bending-resistant, elongated body, preferably a shaft or beam, as indicated in the preamble to claim 7.

On paper making machines, for example, relatively long shafts occur, which serve inter alia as spindles for carrying paper reels. These are now often manufactured as homogeneous or tubular aluminium or steel shafts, possibly with longitudinal circumferential recesses for air-activated clamping segments or the like. It is understood that a shaft of this kind can have a relatively great mass even in the case of comparatively short lengths, especially if the shaft is to carry large loads. On rotation, a shaft of this kind can also come to produce natural frequencies in the speed range which is relevant for this type of application and by doing so possibly limit the velocity of the paper web. In addition, these shafts must often be handled manually when exchanging reels or the like, which means risking coming into conflict with working environment requirements imposed with regard to lifting heavy objects. In the case of large lengths and high stresses, it can also be difficult to obtain sufficient bending resistance with shafts produced according to the prior art

One aim of the present invention is therefore to provide a method for producing a bending-resistant, elongated body, preferably a shaft or beam, and an arrangement for a bending-resistant, elongated body, which method and which arrangement contribute to eliminating or at any rate reducing the aforementioned problems.

According to an embodiment of the present invention, a method is achieved for producing a bending-resistant, elongated body, preferably a shaft or beam, as indicated in claim 1.

An arrangement for a bending-resistant, elongated body, preferably a shaft or beam, as indicated in claim 7, is also achieved according to the present invention.

Preferred embodiments of the method or arrangement have in addition one or some of the features indicated in the respective sub-claims.

The method or arrangement according to the invention have several advantages. By means of the method according to the invention, a bending-resistant, elongated body can be produced, preferably a lightweight shaft or beam, the bending resistance of which is considerably increased and the natural frequency of which can be adapted to the current application.

The invention is to be explained in greater detail below by way of examples of embodiments of the invention and the arrangement and with reference to the enclosed drawings:

Fig. 1 shows a first embodiment of a bending-resistant, elongated body according to the invention in the form of a shaft, in a section at right angles to its longitudinal axis.

Fig. 2 shows a second embodiment of a bending-resistant, elongated body according to the invention in the form of a beam, in a section at right angles to its longitudinal axis.

In Fig. 1, 1 generally describes a bending-resistant, elongated body in the form of a circular shaft of the type which is suitable as a spindle in a paper making machine or the like, for example. The circular shaft 1 has a number of circular cavities 2, 2a, extending essentially along the whole of its length, the inner surfaces of which, in a section at right angles to its longitudinal axis, are at a distance from the mass centre of the section. One of these cavities 2a is arranged concentrically around the mass centre of the section. In comparison with a homogeneous metal shaft, for example, the cavities considerably reduce the weight of the shaft. Fibre composite bodies 3, 3a are applied to the cavities 2, 2a, preferably by gluing, which bodies have outer surfaces essentially congruent with the inner surfaces of the cavities 2, 2a, which outer surfaces due to the affixing are joined to the inner surfaces of the cavities by affixing. The fibre composite bodies 3, 3a may be homogeneous, as in the cavities 2 lying circumferentially, or tubular, like the fibre composite body 3a, which is affixed in the hollow 2a arranged concentrically with the mass centre. The majority of the fibres in the fibre composite bodies 3, 3a extend essentially parallel to the longitudinal axis of the shaft 1 and are elongated along the whole of its length.

The fibre composite bodies 3, 3a consist preferably of carbon fibre in an epoxide matrix, but other fibres and matrices with similar properties are naturally conceivable. For gluing, an epoxy-, acrylic-, polyurethane- or phenolic-resin based adhesive is used.

When manufacturing the shaft according to Fig. 1, one starts by producing a elongated shaft blank with the cavities 2, 2a extending essentially along the entire length of the shaft 1. A fibre composite body 3, 3a, with an outer surface essentially congruent with the inner surface of the cavity is then fitted into each cavity 2, 2a. The majority of the fibres in the fibre composite body 3, 3a should hereby be oriented essentially parallel to the longitudinal axis of the elongated shaft blank and such that they are elongated along the whole of its length.

In Fig. 2, 1 generally describes a bending-resistant, elongated body in the form of a rectangular beam. Like the shaft according to Fig. 1, the rectangular beam 1 has a number of cavities 2, 2a extending essentially along its entire length, the inner surfaces of which cavities, in a section at right angles to its longitudinal axis, are at a distance from its mass centre. As in the previous embodiment, one of these cavities 2a is arranged concentrically around the mass centre. In the cavities 2, 2a, as in the embodiment according to Fig. 1, fibre composite bodies 3, 3a are affixed, preferably by gluing, which bodies have outer surfaces essentially congruent with the inner surfaces of the cavities, which outer surfaces are joined by affixing to the inner surfaces of the cavities. The fibre composite bodies 3, 3a in all cavities are homogeneous in this embodiment. Here also the majority of the fibres extend essentially parallel to the longitudinal axis of the elongated body and are elongated along the whole of its length.

The production of the beam 1a according to Fig. 2 is performed in a corresponding manner to that for the shaft 1 according to Fig. 1.

Bending-resistant, lightweight shafts and beams of an arbitrary cross-section can be produced by the invention. The bending resistance of these can be increased by arranging the inner surfaces of the cavities 2, 2a connecting to the outer surfaces of the fibre composite bodies 3, 3a at a greater distance from the mass centre and reduced in the reverse manner, seen in a section at right angles to the longitudinal axis of the shaft/beam. The above may

also be utilized to give the shafts/beams according to the invention the desired natural frequency. In the case of rotating shafts, it is normally suitable for the cavities 2, 2a to be arranged with an equal pitch, symmetrically around the mass centre of the shaft seen in a section at right angles to its longitudinal axis, while in the case of a beam, varying bending resistance in different directions can be achieved through asymmetrical positioning of the cavities 2, 2a. Due to the fact that the fibre composite bodies 3, 3a are normally of a lower density than the material which is used for the elongated body, a basic reduction in weight is achieved compared with a homogeneous body of the same dimensions. To reduce the weight further, it is possible for certain applications to arrange further cavities 2, 2a, in which fibre composite bodies 3, 3a are not arranged.

It is evident to a man skilled in the art that the invention is not restricted to the embodiments described above, but that it can instead undergo modifications in the scope of the inventive idea defined in the following patent claims. For example, in the case of the embodiments according to Fig. 1 or Fig. 2 it is possible to arrange the fibre composite bodies 3, 3a solely in the cavities 2 lying circumferentially or alternatively only in the hollows 2a executed concentrically with the mass centre. It is understood also that the cavities 2, 2a can have an arbitrary cross-section and that the fibre composite bodies can be affixed in the cavities by shrinking.